

CLAIMS

1. A flip chip package, comprising:

a flip chip bound to an electroless nickel immersion gold packaging substrate;

and

5 a doped solder ball array bonded to under bump metallization on the packaging substrate via an interface, the solder balls of the array comprising,

a Pb/Sn bulk solder, and

a metal dopant selected from the group consisting of Cu, Al and Ni in an amount of at least 0.2% by weight.
- 10 2. The package of claim 1, wherein the metal dopant in the bulk solder bonds or complexes with phosphorus from the under bump metallization.
3. The package of claim 1, wherein the under bump metallization comprises vias filled with successive layers of copper, nickel and gold.
4. The package of claim 1, wherein the metal dopant is in an amount of about
15 0.2% to 2.5% by weight.
5. The package of claim 1, wherein the metal dopant is Cu.
6. The package of claim 1, wherein the metal dopant is Al.
7. The package of claim 1, wherein the metal dopant is Ni.
8. A method of making an electronic apparatus, comprising:

20 providing an electroless nickel immersion gold flip chip package having a doped ball grid array disposed on under bump metallization, wherein the solder balls of the array comprise,

a Pb/Sn bulk solder, and

a metal dopant selected from the group consisting of Cu, Al and Ni in an amount of at least 0.2% by weight;

mounting the flip chip package on a printed circuit board by a solder reflow operation in which the solder of the ball grid array is heated above its melting temperature, the metal dopant forms a compound or complex with a phosphorus residue on the substrate that is mixable with the bulk solder, and a solder bond is formed between the under bump metallization of the package and electrical contacts on the board upon cooling.

9. The method of claim 8, wherein the metal dopant in the bulk solder strengthens the interfacial bond between the solder and the under bump metal metallization of the substrate relative to undoped bulk solder.

10. The method of claim 8, wherein the metal dopant is in an amount of about 0.2% to 2.5% by weight.

11. The method of claim 10, wherein the metal dopant is Cu.

12. The method of claim 10, wherein the metal dopant is Al.

13. The method of claim 10, wherein the metal dopant is Ni.

14. The method of claim 8, wherein the under bump metallization comprises vias filled with successive layers of copper, nickel and gold.

15. An electronic apparatus, comprising:

a flip chip bound to an electroless nickel immersion gold packaging substrate;
a printed circuit board; and

a doped solder ball array bonded to under bump metallization on the packaging substrate via an interface and electrically connecting the package to the printed circuit board, the solder balls of the array comprising,

a Pb/Sn bulk solder, and

a metal dopant selected from the group consisting of Cu, Al and Ni in an amount of at least 0.2% by weight.

16. The apparatus of claim 15, wherein the metal dopant is in an amount of about 0.2% to 2.5% by weight.

5 17. The apparatus of claim 15, wherein the metal dopant is Cu.

18. The apparatus of claim 15, wherein the metal dopant is Al.

19. The apparatus of claim 18, wherein the metal dopant is Ni.